The Relation Between Recent Injections And Paralytic Poliomyelitis in Children*

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SEVERAL factors have been suspected of predisposing individuals to a higher incidence or a more severe form of poliomyelitis. Among these may be mentioned trauma,[1, 2] tonsillectomy,[3, 4] fatigue,[5, 6, 16] and pregnancy.[7, 8] Reports of an apparent relation between prior immunization and poliomyelitis were made by DeTeyssien[9] in 1921, and later by Jermulowicz,[10] Molinari,[11] Banerjea,[12] Mazel, *et al.*,[13] Brain,[14] Verjaal,[15] and Russell.[16] These reports were based on observations made in one or several cases. During 1950 a number of British and Australian investigators reported on studies in groups of cases[17-23] which indicated that in children recently inoculated with pertussis vaccine, diphtheria toxoid, or tetanus toxoid the injected limb was more frequently the site of paralysis than was the case in children not recently inoculated. Hill and Knowelden,[24] in a careful statistical study, corroborated these findings. They also observed that a history of recent immunization was obtained more frequently in cases of poliomyelitis than in matched controls and considered it possible that recent inoculations may have shifted some of the cases of poliomyelitis from the abortive to the clinically recognized group. In this country, Anderson and Skaar[25] have confirmed the British observation of a correlation between the site of injection and the site of paralysis.

On the other hand, Breen and Benjamin[26] found that, out of a total of 356 cases under age 5 in the London outbreaks of 1947 and 1949, only 58 had a history of recent inoculation and in only 33 was a real association established between paralysis and injection. They doubted that the association colored the epidemiological picture of the London outbreaks. McLeod[27] studied an outbreak in Belfast in 1950. He obtained data on immunization from 73 paralytic children, of whom 33 had been inoculated at various times before the onset of their paralysis. He was unable to demonstrate a relationship between the site of injection and the site of paralysis; but he admitted that his experience was limited.

METHOD

The present study includes all cases of poliomyelitis reported to the New York City Department of Health in 1949 and 1950 among children 5 years of age and under from whom an accurate history of previous injections could be obtained. Upon the notification of a case, a complete epidemiological his-

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tory was obtained by a physician within a month of onset. This included the clinical picture, results of spinal fluid examinations, and outcome of the case. In addition, a history of injections received by every member of the family in the age groups studied was obtained. This included the dates of inoculations and types of materials used. A month after onset, cases were revisited by public health nurses, who checked on paralysis. Necessary corrections were entered on the original cards. During 1950, the investigation was extended to include children from 6 to 10 years of age, and the physician also visited a neighboring family in which no case had occurred and obtained a similar inoculation history of all children 10 years of age or under. These histories were used in the selection of a control group.

The data obtained from controls in 1950 were entered on cards and arranged by age and sex. The case histories for that year were similarly arranged. For each case a card was pulled at random from the corresponding control group and the date of onset of the case entered on it. The time span between this assigned date and the date of inoculation provided intervals among the controls comparable to the interval between inoculation and onset among the cases. There were more controls than cases in each group except for age 5, female, and age 8, male. Two controls were lacking in the former and five in the latter. They were obtained from control groups of corresponding age and sex in 1951. Thus, for 1949 and 1950 data were available on the time interval between inoculation and onset of poliomyelitis in the cases, and for 1950 on inoculations and the presumed onsets in the matched controls. The agents used in the injections were also known for both cases and controls.

The data from cases in 1949 and 1950 were arranged by time interval between inoculation and onset. The data for the 1950 controls were similarly arranged. All cases and controls showing an interval of not more than 3 months between inoculation and onset were further checked for accuracy by communicating with the physician who had given the injection and obtaining from his records the dates of and materials used for the inoculations. Confirmations were obtained in about 75 per cent of those questioned. The differences between the statement of the mother and the doctor's records were surprisingly few. Where such a difference existed, the doctor's record was accepted. Where no record was kept by the doctor, the mother's statement was accepted if her reliability was judged to be good. Otherwise the case was not used in the study.

All data were entered on coding sheets and punch cards made. These were processed by tabulating machines.

Since no data on immunization were obtained on children over 5 years of age in 1949, the analyses for the two years are limited to children 5 years of age or under. It should be pointed out that the results apply to the 0–5 year age group, but not necessarily to each year of age in the group. Further analysis is needed to clarify this. Although the figures for the 6–10 year age group are not used in the two year analysis, their inclusion would make no significant statistical change. The discussion of immunization histories in cases and controls is limited to the year 1950 and therefore includes all children aged 10 years or under.

RESULTS

The total number of cases studied was 1,300, of which 681 occurred in 1949 and 619 in 1950. Table 1 indicates their distribution by age, sex, paralysis, and history of previous inoculation. Of the total number, 879 had received their last injection with DPT, 259 with penicillin, and 117 with other or unknown agents. The term DPT signifies an injection with

TABLE 1

Cases of Poliomyelitis by Age, Sex, Paralysis, and History of Previous Inoculation, New York City, 1949–1950

Age In years	Sex			Interval Between Inoculation and Poliomyelitis, in Months								
	Male	Female	Total	0–1	1–2	2–3	3–6	6–12	12+	Not Inoculated	At Onset	Unknown
0–1	51	39	90	41	11	9	4	3	–	19	1	2
Paralyzed	48	37	85	39	11	8	3	3	–	18	1	2
Not Paralyzed	3	2	5	2	–	1	1	–	–	1	–	–
1–5	573	376	949	79	39	32	90	112	516	26	23	32
Paralyzed	413	293	706	56	27	25	78	86	375	20	17	22
Not Paralyzed	160	83	243	23	12	7	12	26	141	6	6	10
6–10	155	106	261	12	4	4	9	26	185	–	12	9
Paralyzed	84	59	143	6	4	3	6	15	98	–	7	4
Not Paralyzed	71	47	118	6	–	1	3	11	87	–	5	5
Total	779	521	1,300	132	54	45	103	141	701	45	36	43

diphtheria toxoid, pertussis vaccine, or tetanus toxoid, singly or in any combination. About 41 per cent had received a triple mixture of diphtheria toxoid, pertussis vaccine, and tetanus toxoid; 27 per cent diphtheria toxoid only; 15 per cent pertussis vaccine alone; and 10 per cent a mixture of pertussis vaccine and diphtheria toxoid. Four per cent had been inoculated with tetanus toxoid only, and an equal percentage with a mixture of diphtheria and tetanus toxoids. Thus, about 80 per cent had been inoculated with diphtheria toxoid, 65 per cent with pertussis vaccine, and 50 per cent with tetanus toxoid. The data were insufficient to permit determination of the influence of each of these antigenic agents alone.

There were 132 children injected not more than a month before onset, 343 between a month and a year prior thereto, and 701 more than a year before. In the latter group, information was obtained about the type of injection, but no attempt was made to learn the exact date of inoculation and the limb injected, since it was felt that the information would not be sufficiently reliable. The 36 children who had been injected on the day of onset had received penicillin in all but one case, probably as a therapeutic measure before a definite diagnosis was made. In 43 instances no information was obtained on the interval between injection and onset of poliomyelitis. In the total group there were 779 boys and 521 girls.

It will be noted that in all age groups, by reference to columns 5 to 9 of Table 1, there is a concentration of cases in the month following the last injection, as was pointed out by Anderson and Skaar.[25] Thus, in age group 0–1 year, 41 cases occurred within a month after the last inoculation; 11 between 1 and 2 months; 9 between 2 and 3 months, 4 between 3 and 6 months, an average of 1 per month; and 3 between 6 and 12 months, an average of 1 case in 2 months. Such a concentration suggests a relationship between recent injection and poliomyelitis.

Injected and Paralyzed Limbs—Information about the exact site of the last injection was available in 160 children in the age group 0–5 years (Table 2). Of these, 80 had been injected with DPT, 31 with penicillin and 49 with other agents.

Among those inoculated with DPT, 27 had received their last injection within a month of onset of poliomyelitis and 53 between a month and a year before. Thirty-three per cent of the former and 13 per cent of the latter were paralyzed

TABLE 2

Relation Between Injected and Paralyzed Limb After Inoculation with DPT, Penicillin, and Other Agents, in Children 5 Years of Age or Under, New York City, 1949–1950

Agent Used	Interval Between Last Injection and Onset of Poliomyelitis, in Months	Number Injected in Known Site	Paralyzed in Injected Limb	
			Number	Per cent
DPT	0– 1	27	9	33
	1– 2	13	2	15
	2– 3	8	0	0
	1–12	53	7	13
Penicillin	0– 1	6	3	50
	1– 2	11	4	36
	2– 3	2	1	50
	1–12	25	7	28
Other agents	0– 1	1	0	—
	1– 2	6	0	—
	2– 3	6	0	—
	1–12	48	6	13
All agents	0– 1	34	12	35
	1– 2	30	6	20
	2– 3	16	1	6
	1–12	126	20	16

in the injected limb, a statistically significant difference.

Among the children who had received penicillin within a year of onset of poliomyelitis, a similar difference was found between those injected not more than a month before and those injected between a month and a year before. However, the numbers were small and the difference was not statistically significant. Among the 49 children injected with other agents, only 1 had received an injection within a month of onset of poliomyelitis. When all agents were combined, there were 34 children injected not more than a month before onset and 12, or 35 per cent of these, were paralyzed in the injected limb. On the other hand, 126 children had been injected between 1 month and 1 year before onset, and 20, or 16 per cent, were paralyzed in the same limb. The difference is statistically significant.

Injection into Unspecified Arms or Legs—In some cases there was information that the injections with DPT had been given in the arm, but whether right or left was not known. The number of these children who developed paralysis in the limbs was ascertained. There were 18 among those inoculated not more than a month before onset of poliomyelitis and 43 among those inoculated from 1 to 12 months before onset. Paralysis of the arms occurred among 56 per cent of the former and 21 per cent of the latter, a statistically significant difference (Table 3).

There were too few children injected with DPT in the legs to permit adequate comparison between the recently and the more remotely injected cases.

All injections of penicillin had been given in the legs. There were 134 children so injected within a year of onset of poliomyelitis. No significant difference in the percentage of paralyzed legs was found between those recently injected and those injected some time before (Table 3).

Weekly Interval Between Injection and Onset—When the cases occurring within a month after injection were arranged by weeks, no marked preponderance of cases was noted in any one week. However, in the DPT-injected children some bunching of cases was noted in the 2nd week after injection. Of the total of 55 cases occurring in the 4 weeks after the last injection, 18, or

TABLE 3

Relation Between Injected and Paralyzed Limbs in Cases Injected with DPT in the Arms and Penicillin in the Legs, Which Arm or Leg Not Specified, in Children 5 Years of Age or Under, New York City, 1949–1950

Agent Used	Interval Between Last Injection and Onset of Poliomyelitis, in Months	Number Injected	Number Paralyzed In Limbs	Number Paralyzed in —
				Arms
DPT	0– 1	24	18	10 (56%)
	1– 2	8	5	1 (20%)
	2– 3	6	6	2 (33%)
	1–12	57	43	9 (21%)
				Legs
Penicillin	0– 1	52	34	29 (85%)
	1– 2	9	5	4 (80%)
	2– 3	8	5	4 (80%)
	1–12	82	49	36 (90%)

TABLE 4

Cases of Poliomyelitis Occurring in the 4 Weeks Following Injection with All Agents, by Days After Injections, Children 0–5 Years of Age, New York City, 1949–1950

Days After Injection	DPT		Penicillin		Other Agents		Total	
	Total Cases	Number Paralyzed	Total Cases	Number Paralyzed	Total Cases	Number Paralyzed	Total Cases	Number Paralyzed
1– 7	11	9	32	25	–	–	43	34
8–14	18	18	11	7	1	1	30	26
15–21	14	12	8	5	1	1	23	18
22–28	12	10	7	4	–	–	19	14
Total	55	49	58	41	2	2	115	92

33 per cent, occurred in the 2nd week. In the 1st, 3rd, and 4th weeks after the last injection with DPT, there were 11, 14, and 12 cases, respectively. Furthermore, all 18 cases that occurred in the 2nd week were paralytic, while in the other three weeks the paralytic cases were respectively 9, 12, and 10 (Table 4).

Evaluation of the group last injected with penicillin is somewhat complicated. A large number of cases, 32 out of a total of 58, occurred in the 1st week after the last injection of penicillin, most of them in the first 3 days. One wonders whether many of these injections were given therapeutically, after the child became ill with poliomyelitis and before a diagnosis was made. If this is the case, then the apparent adverse effect of recent injections of penicillin noted in some of the tables may not be of any importance. In none of the tables was the difference between the effect of recent and remote injections of penicillin large enough to be of statistical significance. However, even the slight differences may be wiped out if some of the injections were given after onset but before symptoms were sufficiently characteristic for a diagnosis to be made.

The cases injected in a known site in the month preceding onset of poliomyelitis were also arranged by week of onset after injection. The numbers of injected limbs paralyzed in each week were too small to allow the emergence of any particular pattern (Table 5).

Ratio of Arm to Leg Paralysis— Since four-fifths of all DPT injections had been given in the arms and all penicillin injections in the legs, it appeared

TABLE 5

Relation Between Injected and Paralyzed Limb in Cases of Poliomyelitis, by Week After Injection, Children 0–5 Years of Age, New York City, 1949–1950

Days After Injection	Number Injected in Known Site				Paralyzed in Injected Limb			
	DPT	Penicillin	Other Agents	Total	DPT	Penicillin	Other Agents	Total
1– 7	6	3	–	9	2	1	–	3
8–14	7	2	1	9	1	1	–	2
15–21	5	–	–	6	2	–	–	2
22–28	7	1	–	8	3	1	–	4
Total	25	6	1	32	8	3	–	11

TABLE 6

Ratio of Leg to Arm Paralysis in Children 5 Years of Age or Under, Inoculated with DPT or Penicillin, or Not Inoculated, New York City, 1949–1950

Agent Used	Interval Between Last Injection and Onset of Poliomyelitis, in Months	Number of Children Paralyzed in Limb			Number of Limbs Paralyzed		
		Arms	Legs	L/A	Arms	Legs	L/A
DPT	0– 1	22	33	1.5	27	44	..6
	1– 2	4	13	3.3	4	20	5.0
	2– 3	6	13	2.2	8	19	2.4
	1–12	24	83	3.5	29	111	3.8
Penicillin	0– 1	9	33	3.7	10	49	4.9
	1– 2	7	9	1.3	8	11	1.4
	2– 3	1	5	5.0	2	8	4.0
	1–12	23	53	2.3	28	69	2.5
None	Not Inoculated	10	31	3.1	12	42	3.5

profitable to compare the ratios of leg to arm paralysis in the two groups, whether the site of injection was known or not. It will be noted in Table 6 that among the children not inoculated, three to four times as many were paralyzed in the legs as in the arms. This held true also for children inoculated with DPT more than a year before onset and between 1 month and 1 year before onset. However, among those children injected with DPT not more than a month before onset, almost as many arms as legs were paralyzed, indicating a definite influence of the injecting agent.

In the penicillin-injected group, where all injections were given in the legs, a greater percentage of leg paralysis occurred among the children inoculated within a month than among those inoculated more than a month before onset of poliomyelitis. The difference was not statistically significant and, as already indicated, there is doubt that all the injections preceded onset of poliomyelitis.

In both the DPT and the penicillin groups the ratios of arm to leg paralysis were approximately the same, whether one compared paralyzed children or paralyzed limbs. In the group injected with other agents, the figures were too small in some categories to make comparisons worth while.

Severity of Cases—Studies on the severity of poliomyelitis following tonsillectomy indicate that the bulbar type is many times more frequent in cases that have had a recent tonsillectomy than in those that have had none or that had one in the more distant past.[3, 4] It was of interest to determine whether this held true also for children recently injected. In Table 7 the cases that had

received an injection of DPT or penicillin were arranged according to clinical types. Those called spinal paralytic had paralysis resulting from involvement of the spinal cord only; those called bulbar had involvement of a cranial nerve or medullary center, alone or combined with paralysis of the trunk or a limb, and accounted for almost all the deaths. For comparison, the cases that had never been inoculated were similarly arranged. It will be seen that the percentage distribution of cases inoculated with DPT within a month of onset of poliomyelitis according to nonparalytic, spinal paralytic, and bulbar types hardly differs from the percentage distribution of cases inoculated 1 month to 1 year before onset, or of those not inoculated.

Similar comparison made in children previously injected with penicillin also shows no significant difference in severity of the poliomyelitis, whether the injections had been given recently or some time in the past. An analysis made separately for children under 1 year of age, for those between 1 and 5 years, and for those in the 6 to 10 year age group also showed no significant differences in the types of clinical poliomyelitis, whatever the agent used and whatever the time interval between injection and onset of poliomyelitis.

Anderson and Skaar[25] also found no increase in bulbar cases in the recently injected group. However, they divided their spinal paralytic cases into severe and mild paralysis. They were able to demonstrate a more severe paralysis in the children immunized in the previous

TABLE 7

Cases of Poliomyelitis According to Clinical Type and History of Previous Inoculation with DPT or Penicillin, Children 5 Years of Age or Under, New York City, 1949–1950

		Interval Between Last Inoculation and Poliomyelitis, in Months									
		0–1		1–2		2–3		1–12		Not Inoculated	
Agent Used	*Type of Case*	*No.*	*%*	*No.*	*%*	*No.*	*%*	*No.*	*%*	*No.*	*%*
DPT	Nonparalytic	7	12	5	23	2	9	20	15	7	16
	Spinal "	44	75	15	68	13	62	90	68	33	73
	Bulbar "	8	13	2	9	6	29	22	17	5	11
	Total	59	100	22	100	21	100	132	100	45	100
Penicillin	Nonparalytic	17	29	7	35	4	40	30	28		
	Spinal "	37	64	13	65	5	50	62	57		
	Bulbar "	4	7	0	—	1	10	16	15		
	Total	58	100	20	100	10	100	108	100		

TABLE 8

Comparison of the Histories of Injections with DPT or Penicillin of Cases of Poliomyelitis, Children 10 Years of Age or Under, and in Their Matched Controls, New York City, 1950

Agent Used	*Interval Between Last Injection and Onset of Poliomyelitis, in Months*	*Cases*	*Controls*
DPT	0– 1	26 (33%)	6 (10%)
	1– 2	8 (10%)	10 (16%)
	2– 3	7 (9%)	5 (8%)
	1–12	52	57
Penicillin	0– 1	27 (24%)	13 (13%)
	1– 2	7 (6%)	12 (12%)
	2– 3	9 (9%)	8 (8%)
	1–12	84	91

month than in those inoculated 2 to 6 months before. We did not have sufficient information on severity of paralysis to make such an analysis.

The other agents injected not more than a month before onset of poliomyelitis were too few in number to make discussion of them of value.

Controls—During the 1950 investigation, the physician who obtained the immunization history of the family in which a case occurred also obtained a similar immunization history from a neighboring family where no case had occurred. By matching controls to cases, as indicated earlier in this paper, one could compare the number of injections that cases and their matched controls had received recently and in the past. The distribution of the different types of immunizing agents was essentially the same in cases and in controls:

	Cases		*Controls*	
	No.	*%*	*No.*	*%*
Diphtheria toxoid	45	11	43	10
Pertussis vaccine	12	3	12	3
Tetanus toxoid	6	2	7	2
Diphtheria toxoid and pertussis vaccine	178	44	212	49
Diphtheria and tetanus toxoids	5	1	4	1
Diphtheria and tetanus toxoids and pertussis vaccine	159	39	147	35
Total	405	100	425	100

The results are shown in Table 8. It will be noted that for both DPT and penicillin a significantly larger percentage of cases than of controls had been injected within a month of onset of poliomyelitis than in the preceding 11 months. In the group injected with other agents, the numbers were too small for valid comparison. When the total group of 619 cases and a similar number of controls were compared, the results were similar (Table 9). Only in the groups injected not more than a month preceding the onset of poliomyelitis was there a significant difference between the percentages of cases and controls that had received injections, two and a half times greater in the former than in the latter.

DISCUSSION

This investigation corroborates the published findings of other investigators that there is a relationship between recent inoculation with diphtheria toxoid, tetanus toxoid or pertussis vaccine (DPT) and the development of paralytic poliomyelitis. This is indicated by the fact that a significantly larger percentage of children was paralyzed in the injected limb when the last injection had been received not more than a month preceding onset of poliomyelitis than when received from a month to a year before. Also, where the precise site of injection was not known, but where it was known that the injection of DPT had been given in the arms, a similar difference occurred in the percentage of arm paralysis, depending on whether the inoculation prior to onset of poliomyelitis was recent or remote.

TABLE 9

Comparison of the Histories of Injections with All Agents in Cases of Poliomyelitis, Children 10 Years of Age or Under, and in Their Matched Controls, New York City, 1950

	Total		*Interval Between Last Injection and Onset of Poliomyelitis, in Months*											
			0–1		*1–2*		*2–3*		*1–12*		*12+*		*Not Injected*		*At Onset or Unknown*	
	No.	*%*	*No.*	*%*	*No.*	*%*	*No.*	*%*	*No.*	*%*	*No.*	*%*	*No.*	*%*	*No.*	*%*
Cases	619	100	56	9.0	19	3.0	21	3.4	163	26.3	334	54.0	14	2.3	52	8.4
Controls	619	100	21	3.4	25	4.0	15	2.4	173	27.9	358	57.8	18	2.9	49	7.9

Furthermore, in all inoculations with DPT, 85 per cent of which had been given in the arms, the usual ratio of leg to arm paralysis changed from about 3 to 1 to approximately 1 to 1 when the inoculation had been given not more than a month before onset. If the interval between injection and onset was greater, or if there had been no inoculation, the usual ratio prevailed.

The separation of cases that occurred in the month following the last injection of DPT, by weeks of incidence, showed some bunching of cases in the 2nd week. This suggested that the effect of the injection was felt mainly during the incubation period.

The results of injections with penicillin were not clear-cut. An analysis of the cases that followed within a month after the last injection of penicillin indicated a concentration of cases in the first few days after the injection. There is a strong probability that these injections were given therapeutically after onset but before a diagnosis was made. If these cases are omitted, even the slight differences that were occasionally noted between the effects of recent and more distant injections of penicillin lose their significance. It is pertinent to mention that in the next to last column of Table 1 there are noted 36 cases of poliomyelitis that had been injected on the day of onset. They were not used in the comparison of recent and remote injections. All but one of the injections were of penicillin. Here, too, the supposition is strong that the injections were given therapeutically, after onset.

An analysis of the histories of previous inoculations, obtained from cases of poliomyelitis in 1950 and from their matched controls, indicated that a significantly larger percentage of cases than of controls had received injections in the month preceding onset, or presumed onset, of poliomyelitis. This was true both for DPT and for penicillin. It suggests, but does not prove, that there may be an increased incidence of recognizable poliomyelitis in recently injected children. The possibility is enhanced by the fact that, as noted before in Table 1, a concentration of cases is seen in the month following the last injection. Whether this applies to penicillin- as well as to DPT-injected children depends, as previously stated, on whether injections of penicillin, given presumably before onset of poliomyelitis, had not really been given before diagnosis but after onset. Further study should elucidate this problem.

It is true that in all comparisons made, the actual numerical differences, even when statistically significant, were small. However, for DPT, the consistency of the trend and the fact that a number of other investigators found similar differences tend to strengthen the hypothesis that a definite relationship exists between recent injections and poliomyelitis. Hill and Knowelden [24] and Anderson and Skaar [25] have stressed the fact that the relationship exists only for recent injections. As in the case of tonsillectomy, there is no evidence in our investigations, either, that injections received in the more distant past have any influence whatever on the localization or occurrence of poliomyelitis. It should be noted in Tables 2, 3, 6, 8, and 9 that the differences found by a comparison of the intervals 0–1 and 1–12 months after last inoculation do not obtain when similar comparisons are made between the interval 1–2 or 2–3 months after the last injection and the rest of the year. Obviously, the influence of the last injection does not extend beyond a month following the last injection.

When the injected cases were separated according to clinical types, there was no evidence that recent injections have any influence on the bulbar type of poliomyelitis, and therefore on deaths. The percentage distribution of cases recently injected with DPT was little

different from the distribution of non-injected cases. No attempt was made to divide the spinal paralytic cases into mild and severe ones. There is some indication in the work of others[25] that recent injections tend to favor a more severe form of spinal paralysis.

The practical question that presents itself to health officers and physicians generally as a result of these and other published data is, what should their attitude be toward routine and other inoculations during the season of increased incidence of poliomyelitis? There are no published data to indicate the relative incidence of poliomyelitis in recently injected as compared with non-injected children. Korns, Albrecht, and Locke have estimated that the incidence of poliomyelitis in persons inoculated not more than 2 months before onset of poliomyelitis is about twice that of the uninoculated.[28] In New York City the median of annually reported cases of poliomyelitis is about 600, and less than 3 per cent of these occur in children under 1 year of age. In 1950, a little over 1,000 cases were reported. By actual count, 27 of these were in infants under 1 year of age and 18 of them had received an injection of some kind during the year. Ten infants had been inoculated with DPT not more than 2 months before onset.

Presumably, if no inoculations had been given to infants under 1 year of age in 1950, half of the 10 cases would have come down with poliomyelitis. The extra hazard from inoculations was therefore limited to 5 children in a year when 1,000 cases were reported. In an average year, when about 600 cases are reported, the extra hazard might involve 3 children, or 1 child in about 50,000 of that age in the population. The risk is probably even lower, since for 6 to 8 months of the year children are hardly exposed to poliomyelitis. In smaller communities the extra hazard applies to even fewer infants. It becomes obvious that although the risk to infants under a year of age from recent injections with DPT is scientifically a true one, in practice it is more academic than real. Infants under 6 months of age constitute about one-half of one per cent of all cases of poliomyelitis. The extra hazard to them is so small as to be negligible.

It appears reasonable to continue routine immunizations in infants under 6 months of age irrespective of the incidence of poliomyelitis in the community. In a nonepidemic year, routine immunizations may even be permitted in infants under 1 year of age. In older children, routine inoculations should be deferred until after the poliomyelitis season. In the presence of a severe epidemic it may be wise to defer routine inoculations among infants over 6 months of age as well as among older children. There should be no suspension of therapeutic inoculations at any time, first, because there is insufficient evidence that their effect is like that of injections with antigens; and second, because the risk of withholding them is greater than the extra risk of the injection. This holds true, also, for immediate prophylactic injections, such as booster doses of tetanus toxoid in an injured child, antirabic injections, typhoid vaccine for contacts to a case, diphtheria toxoid for nurses beginning service on a communicable disease ward, etc. In all these situations there is a greater risk in withholding the injection than in giving it.

CONCLUSIONS

1. The inoculation histories of 1,300 children that had poliomyelitis in New York City in 1949 and 1950 were analyzed.

2. A relationship was shown to exist between site of injection and site of paralysis in children injected not more than a month before onset of poliomyelitis with diphtheria toxoid, pertussis vaccine, or tetanus toxoid, or any combination of the three.

3. This relationship was not clearly shown to follow recent injections of penicillin or other agents.

4. No increase in bulbar cases or deaths resulted from previous injections.

5. A comparison of 619 children with poliomyelitis and their matched controls indicated that a larger percentage of cases than of controls had had recent injections. This suggested that the incidence of recognizable poliomyelitis may be greater in children recently injected than in those not injected or injected in the past.

6. The extra hazard of poliomyelitis as a result of recent inoculations is small in children under 1 year of age and is negligible in infants under 6 months of age.

7. It appears reasonable to continue immunizations in infants under 6 months of age at all times. During nonepidemic years, immunizations may be given to infants under 1 year of age throughout the year. Routine immunizations may well be suspended in older children during the poliomyelitis season. In epidemic years the suspension might be extended to infants between 6 months and 1 year of age.

8. Therapeutic and immediate prophylactic injections should not be discontinued at any time.

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